



**WYOMING DEPARTMENT OF ENVIRONMENTAL QUALITY**  
**AIR QUALITY DIVISION**  
**122 WEST 25TH STREET**  
**HERSCHLER BUILDING, 4-WEST**  
**CHEYENNE, WY 82002**

**FAX TRANSMITTAL COVER SHEET**No. of Pages: 9 (Cover Sheet Included)DATE: February 11, 1999TO: SWYTAF Technical Committee (See List Below)FROM: D. Potter *Dale* PHONE NO.: (307)777-7391

COMMENTS: The Division has received some information from Earth Tech which we are forwarding for your review. The attached information addresses Air Sciences responses to questions/comments, inventory-model source reconciliation, railroad emissions, and current status of SOA modeling. As additional information is received it will be forwarded to you for your review. Upon receipt of all requested information a technical committee conference call will be scheduled to discuss responses and feedback for Earth Tech.

If you have questions, please feel free to contact me at (307)777-7346 or by E-Mail (dpotte@missc.state.wy.us.)

Terry Svalberg (USFS)	-	(307)739-5750
Susan Caplan (BLM)	-	(307)775-6082
Dan Heilig (WOC)	-	(307)332-6899
Tamara Blett (USFS)	-	(303)275-5754
Otto Schnauber (Tg Soda Ash)	-	(307)872-4233
Baptiste Weed (Wind River EQC)	-	(307)332-7579
Doug Blewitt (Amoco)	-	(303)830-4275
Dolly Potter (Solvay)	-	(307)872-6510
Kevin Golden (EPA)	-	(303)312-6064
Lee Gribovicz (DEQ/AQD)	-	(307)332-7726

Copy: Dan Olson ✓  
Bernie Dailey ✓

**IF YOU DID NOT RECEIVE ALL OF THE PAGES, PLEASE NOTIFY THE SENDER AS SOON AS POSSIBLE.**

OFFICE NO. (307) 777-7391

FAX NO. (307) 777-5616

**SOLVAY2016\_1.4\_001833**

*SWYTAF*

**From:** Joe Scire <jss@src.com>  
**To:** incdomain.misscsmtpt(\"Dan Olson <dolson@missc.sta...  
**Date:** 02/08/99 7:23am  
**Subject:** SWWYTAF Status

Dan,

Attached are four additional memos relating to various aspects of the SWWYTAF project. You may have already received the Air Sciences memo separately.

Regarding the schedule, completion of the remaining items, including responses to outstanding questions, will be completed by Feb 19. Allowing a two-week period for responses and feedback, the final runs will be started in the first week of March.

Thank you for your patience. Please let me know if there are any questions on the material provided today.

Regards,

Joe



AIR SCIENCES INC.

**MEMORANDUM****TO:** Joe Scire,  
Darla Potter**DATE:** February 9, 1999**FROM:** Rodger Steen**PROJECT:** 131-2**SUBJECT:** Response to January 13 questions to Earth Tech - Volume 2

---

**Question: Inclusion of Amoco Whitney Canyon emissions**  
Yes, they are included.**Question: Gas wells in the inventory that are in Colorado**  
The two wells in question are located in Colorado according to the PAW location information provided Air Sciences. However, they are within 300 meters of latitude 40.0 degrees, so we suspect that it is due to transformation for one coordinate system to another or rounding of location information. Air Sciences will move the wells north to 40.0 degrees latitude, add them into the grid cells immediately to the north, and eliminate the southern-most row of cells from the spreadsheets in the report.**Question: explain how the flare stack parameters in Wyoming were derived**  
Air Sciences used the values provided by the DEQ in a memo. We will reference this memo in the report.**Question: default values of flares in Utah**  
There are five flares at two refineries near Salt Lake City for which Utah did not provide stack parameters. Air Sciences developed default values for these from other similar stacks in Utah, provided by Utah. We did not judge the correctness of these values. If the SWWYTAF technical group suggests alternate values, they can be substituted for the present default values. We will wait for the SWWYTAF decision on this before finalizing the emissions files.12596 WEST BAYAUD AVENUE  
LAKEWOOD, COLORADO 80228  
(303) 988-2060 FAX 988-2062

SOLVAY2016\_1.4\_001835



AIR SCIENCES INC.

MEMORANDUM  
Joe Scire  
February 9, 1999  
Page 2

**Question: Note in the report that fugitive PM10 emissions from the drill pads and associated access roads are not inventoried.**

**We will make this notation**

**Question: cord density and smoke emissions calculation**

Air Sciences agrees with the Forest Service that the density of a cord of wood should be used instead of the density of a piece of wood and we will make this correction. From the supplied forest Service information, the ratio of the two is 72%. So, emissions will decrease to 72% of those reported. Corrections will be made to Tables 4.5, 4.16, 5.1, and to Appendices G and I.

**Note on Utah Stack Parameters**

It is apparent from the Appendix A2 data that several Utah stack velocities are suspect (too low). However there is no consistency on this by county or source type. We have checked these again with Utah with unsatisfactory response. Since these stacks are several hundred kilometers away from the impact area of interest and the emission rates appear to be correct, the effect of using incorrect velocities will be only on the level of the atmosphere into which the emissions are released.

## Technical Memorandum

### Inventory – Model Source Reconciliation

Before the final round of modeling it is important to determine if the processing of the emissions inventory into the sources seen and reported by CALPUFF has been completed properly. Emissions statistics of  $\text{NO}_x$ ,  $\text{SO}_2$ , particulates and VOC's from Table 5.1 of Volume II of the emissions report were compared with the emission rates as output by CALPUFF and which are summarized in Volumes I and III of the emissions report.

#### 1.0 $\text{NO}_x$ emissions

The CALPUFF post processing software outputs the mass emission rate of NO and  $\text{NO}_2$  separately.  $\text{NO}_x$  is estimated as  $\text{NO}_2$  by assuming a 9:1 NO: $\text{NO}_2$  speciation ratio and multiplying NO by 46/30, the ratio of the molecular weights. The g/s are converted to tons/year using the factor 34.69 which assumes 365 days per year. The reconciliation statistics for  $\text{NO}_x$  are summarized in Table 1. The numbers in parentheses contain the Utah DEP county estimates of facility point sources. Air Science supplied separate estimates for such points also in the totals in parentheses. To avoid double counting Air Sciences removed the Utah DEP point source estimates before sending the data sets to Earth Tech. This table shows that the CALPUFF emissions agree to better than 1% those reported by Air Sciences.

Table 1. Source reconciliation for 1995 annual  $\text{NO}_x$  emission estimates throughout the modeling domain.

Source	AirScience (tons/year)	CALPUFF (g/s)	CALPUFF (tons/year)
Wyoming			
Facilities	72829	2114.14	73348
Petroleum	3781	108.96	3780
Urban	4582	132.07	4582
Total	81192	2355.19	81710
Utah			
Total	79307 (102190)	2284.6	79253
Idaho			
Facilities	6595	189.74	6582
Urban	5494	158.32	5492
Total	12089	348.06	12074
grand total	172588 (195471)	4987.85	173037

## Memorandum

### Summary of Railroad Emissions in the SWWYTAF Domain

The railroad emissions group consists of just the line haul emissions in the Wyoming and Idaho portions of the SWWYTAF modeling domain. Switchyard emissions such as those at Green River are part of the city emissions due to their location and the fact that emissions are confined to the switchyard. The railroad emissions in Utah are contained in the county area emission files. At the present time it is not possible to accurately break out just the railroad emissions from the county totals for all of the counties.

The NO<sub>x</sub> emissions are derived from the locomotive emission factors given in the EPA technical highlights dated December 1997 (EPA-420-F-97-051). These factors differ from those in EPA 540/4-81-02d (Revised). A separate breakout of the total annual emissions by state (Idaho and Wyoming) was performed. This information is summarized in Table 5-16 presented below. (This table supersedes the original Tables 5-16 and 5-17 of the draft emissions report)

Table 5-16. A summary of the estimated line haul emissions during 1995.

Pollutant Specie	CALPUFF total emission rate (g/s)	Explicit Rail Haul Emissions (tons/year)	WY Explicit Rail Haul Emissions (tons/year)	ID Explicit Rail Haul Emissions (tons/year)
SO <sub>2</sub> <sup>2</sup>	41.0	1,423	845	578
NO <sub>x</sub> <sup>1</sup>	561.7 (as NO <sub>2</sub> )	19,492	11,570	7,922
NO	329.7			
NO <sub>2</sub>	56.2			
PM <sup>1</sup>	14.0 (total)	483	287	196
COARSE	1.4			
PM <sub>2.5</sub>	12.6			
VOC <sup>1</sup>	20.8 (includes NR)	722	428	294
TOL	1.4			
XYL	1.6			
NR (nonreactive)	17.8			

<sup>1</sup> Emissions factors are from EPA420-F-97-051

<sup>2</sup> SO<sub>2</sub> emission factors are from Meeker memorandum March 17, 1997

## Technical Memorandum

### Current Status of Secondary Organic Aerosol (SOA) Modeling -- REVISED (01/25/99)

The initial SOA modeling exercise indicated a significant degree of model over prediction of organic aerosol. This over prediction was thought to occur because of

- Over estimate of biogenic emission factors and plant biomass,
- Inaccurate beta/alpha pinene emission ratio,
- Over estimate of aerosol formation yield based on (1) too large a background organic aerosol mass and (2) incomplete/uncertain yield model, and
- Biases in the specification of the biogenic area sources used in CALPUFF

Earth Tech has looked into the reasons for the initial over estimates and in the process (1) developed several types of conifer canopies, (2) a new area source grid, (3) new beta/alpha pinene emission ratios, and (4) a revised yield model. A correction was also made in the diurnal weights input to CALPUFF so that hourly weights now sum to 1.0. Details of the changes in the biogenic emissions inventory estimation are discussed in volume 1 of the emissions report. A sensitivity study was conducted and in the process a new set of SOA predictions was produced which shows better agreement with the observations of organic aerosol mass over the receptor area. This technical memorandum discusses some results of the revised SOA modeling.

The SOA model itself was revised by the addition of a separate night time yield model for alpha pinene which reacts rather quickly with ozone. The yield curve information of Hoffmann et al. 1997 for dark experiments resulted in a one-product yield model for alpha-pinene for night time conditions. The combination day time - night time yield models produces larger aerosol formation yields than the original generic yield model. This results in a greater daily aerosol formation, counter to what was initially expected given the competition between alpha pinene destruction by ozone and the OH radical.

#### Sensitivity Testing Results

A sensitivity simulation was conducted using the high emitting canopy described in Table 7-1 of the draft final emissions report. The emission rates are summarized in section 7 of the draft final report. The background ambient aerosol mass was unchanged from the original simulation. CALPUFF was exercised for the month of July.

The observations of aerosols are generally summarized on a quarterly basis by season. The summer sensitivity simulation of SOA covers only the month of July. According to the IMPROVE report the regionally (Central Rockies group) and historically averaged concentration during the summer is  $1.8 \mu\text{g}/\text{m}^3$ . If the same peak to mean ratio is assumed to occur between months as occurs between seasons the largest observed monthly concentration could be of the

order  $2.5 \text{ ug/m}^3$ . The Bridger aerosol monitor lies 10 km east of Pinedale at a ski resort. The Appendix H of the WY DEQ's 1997 Long Term Strategy for Visibility Protection Review Report shows trend data where at Bridger the organic aerosol observations have apparently declined over time with 1995 data showing summer seasonal average concentrations below  $1.0 \text{ ug/m}^3$ . Biogenic emissions would show interannual differences due to factors like temperature, but would not be expected to show such a decline over time. During July the maximum predicted ambient concentrations of anthropogenic SOA precursors (xylene and toluene) are remain well over an order of magnitude smaller than the corresponding predicted monoterpene ambient concentrations. Trends in the anthropogenic SOA precursors would at present seem to small to have much of an effect leaving the source of trend, if it is real, unaccounted for.

The original maximum monthly mean biogenic SOA concentration for July was  $17.4 \text{ ug/m}^3$  – clearly an over prediction of SOA. The predicted SOA for the revised high emitting canopy is  $3.46 \text{ ug/m}^3$ , a factor of five-fold reduction and more clearly in line with concentration observations. The maximum daily mean predicted SOA concentration also declined by a factor of five, falling from  $41 \text{ ug/m}^3$  to approximately  $8 \text{ ug/m}^3$ . The location of the maximum monthly predicted moved from the northern portion of the receptor region to a receptor in the mid-portion of the modeling domain.

Originally the maximum monthly ambient concentration of beta pinene was larger (unmatched in space) than that of alpha pinene, while for the revised run the highest concentrations of alpha pinene are nearly twice as large as for beta pinene. While this is consistent with the emission inputs (8057 g/s versus 4461 g/s) it is not consistent with ambient air observations of Goldman et. al. 1997 made as part of the Tropospheric OH experiment in the Colorado Rockies which show ambient beta/alpha pinene ratios of greater than two. A reversal of the relative emissions ratio 75/25% (beta/alpha) rather than 25/75% is being examined.

Despite the large decrease in the estimated domain-wide total emissions between the original and the revised sensitivity simulations (182,000 g/s versus 12,700 g/s) the ambient monthly mean concentrations actually increased with maximum alpha pinene concentrations rising to  $118 \text{ ug/m}^3$  from  $28 \text{ ug/m}^3$ . A significant portion of the difference is thought to be due to the difference in the configuration of the area source emissions with finer spatial resolution occurring near the receptor area and a closer match with underlying terrain in the revised run.

A set of four, 1-month simulations were made using a background aerosol mass of 50% of the original simulation ( $5\text{-}7 \text{ ug/m}^3$  instead of  $10\text{-}14 \text{ ug/m}^3$ ). The simulations were made for both January and July for the high and moderate emitting canopies discussed in the draft final emissions report. A reversal was made in the beta-to-alpha pinene ratio so that the ratio is 75%/25% at night rather than 25%/75%. The maximum predicted SOA concentrations in the receptor array are summarized in Table 1. The results indicate that during July the high emitting canopy produces SOA concentrations of  $2 \text{ ug/m}^3$  which falls between the average and the year-receptor specific organic aerosol concentrations observed in the region. The maximum daily SOA average concentration of  $4.6 \text{ ug/m}^3$  is in the mid-range of the Bridger Wilderness fine particle mass scatter plot shown in Figure 6.17 of the IMPROVE report. In contrast, the daily maximum of  $1.8 \text{ ug/m}^3$  obtained using the moderate emitting canopy is rather on the low side and is potentially not conservative.

Table 1. A summary of predicted maximum SOA concentrations ( $\text{ug/m}^3$ ).

*max?*

Canopy type/month	Monthly Average	Daily Average
High - July	2.2	4.6
Moderate - July	0.87	1.8
High - January	0.24	1.3
Moderate - January	0.096	0.5

The January average maximum predicted SOA concentration of  $0.24 \text{ ug/m}^3$  obtained using the high emitting canopy is consistent with observations which suggest average concentrations less than  $0.5 \text{ ug/m}^3$ . The moderate emitting canopy predicts less than  $0.1 \text{ ug/m}^3$  which seems rather low compared with observations. The maximum daily concentration of  $1.3 \text{ ug/m}^3$  obtained using the high emitting canopy again lies in the midrange of observations. Based on findings to date Earth Tech recommends that the high emitting canopy be used with the 75%/25% nighttime monoterpene speciation and the halved background FPM concentrations.

### References

Goldan, P. D., W. C. Kuster, and F. C. Fehsenfeld, 1997. Nonmethane hydrocarbon measurements during the tropospheric OH Photochemistry Experiment, J. of Geophys. Res., 102(D5):6315-6324.

Hoffmann, T. J.R. Odum, F. Bowman, D. Collins, D. Klockow, R.C. Flagan, J.H. Seinfeld, 1997. Formation of Organic Aerosols from the Oxidation of Biogenic Hydrocarbons, J. of Atmos. Chem., 26:189-222.

From: "Rodger G. Steen" <rsteen@airsci.com>  
To: "'ET Joseph S. Scire'" <jss@src.com>, "'WY Darla P...  
Date: 02/11/99 8:51am  
Subject: Utah stack exit velocities

After discussing the stack velocity discrepancies with Utah, they inform us that the requested flow rate from the sources and most are in actual cubic feet per second (ACFS) but some are in ACFM. It simply depends on what the sources within the state reported to Utah. (Air Sciences calculates velocity from flow rate and exit diameter.)

Air Sciences suggests that we assume all flow rates are in ACFS (as Utah had requested of the sources), then screen for excessive velocities (say > 400 feet per second on IC engine velocities and > 80 feet per second for all other sources. If the velocities exceed these thresholds then we will assume flow rate was in ACFM.

We believe that this approach will give us a very good guess as to the correct flow rate and is relatively easy for us to perform. Our current data base assumes that all flow rates are in ACFM.

-----  
Rodger G. Steen  
Air Sciences Inc.  
rsteen@airsci.com  
-----

CC: "Caryn L. Fraundorfer" <Windows/SPIKE/caryn@airsci...